The Farmington River Watershed Road Salt Review

Farmington River Watershed- Route 8 Corridor
In the Towns of Becket, Otis, Sandisfield and Tolland

Prepared for
The Massachusetts Executive Office of Environmental Affairs
Farmington River Watershed Team

By
Michael J. Mattos
Graduate Research Assistant
Directed by
Robert L. Ryan
Assistant Professor

The Department of Landscape Architecture and Regional Planning
University of Massachusetts, Amherst
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Introduction:

This report has been prepared for the Massachusetts Executive Office of Environmental Affairs (EOEA) and Farmington River Watershed Team in response to on-going local concerns regarding salt content in drinking water and will be distributed to the municipalities within the Farmington River Watershed. The report is intended to serve as a resource document for assessing the current and potential impact of road salt on the Farmington River, as well as on the public and private water supplies within the watershed.

For the purposes of this report, the study area was limited to the towns of Becket, Otis, Sandisfield and Tolland. Specifically, the Route 8 corridor within these communities has been targeted for analysis to identify areas of non-point source storm water pollution to the Farmington River, the impacts to wells, and to provide possible remediation alternatives for the communities.

Geographically, the study area along Route 8 begins at the intersection of Route 20 in Becket and runs approximately 15 miles south parallel to the Farmington River to the Connecticut border, where the Farmington River feeds into the Colebrook Reservoir, the City of Hartford's future water supply (See Farmington River Watershed Map).

Figure 1. Colebrook Reservoir, an impoundment along the Farmington River

There are approximately 150 wells located along the Route 8 corridor between the towns of Becket and Tolland. Approximately ten are public wells, which are subjected to regular testing practices regulated by the Massachusetts Department of Environmental Protection (MA DEP). The majority of the wells (approximately 83) are found in the town of Otis where most of the development along Route 8 is located. The Town of Tolland has the fewest, with only one private residential well that abuts Route 8. The Town of Sandisfield has 42 public and private wells and the Town of Becket has 24 wells.

This report will attempt to explain the impacts to these wells by the elevated levels of sodium chloride (salt). It will present an overview of sodium chloride as one source of non-point source pollution and discuss the way in which this contaminant moves through the hydrologic cycle. This report will also review the regulations and standards that govern the acceptable limits of sodium levels in public and private water supplies, as well as the past and most recent well data for the study area.

In addition, the road salting policy and salt complaint policy of the Massachusetts Highway Department (MHD) will be summarized by explaining the salt mixture and application ratios used, the salt storage practices and the criteria implemented for private well testing and replacement.

The conclusion of the report will recommend alternatives that the Farmington Watershed communities may pursue to address possible issues of sodium chloride pollution in the public and private water supplies along the Route 8 corridor.

Sodium as a Contaminant:

Sodium is a natural constituent of groundwater. In Massachusetts, normal background concentrations of sodium in freshwater range from 0.5 milligrams per liter (mg/l) to 15 mg/l (MA DEP, 1991). However, high sodium concentrations in groundwater can result from the use and storage of road salt (sodium chloride). The sodium chloride is soluble in water and can enter the groundwater as run-off from uncovered piles of road salt piles and salt treated roads.

In Massachusetts, the Division of Water Pollution Control found 70% of rivers, coastal waters and almost 100% of all lakes to be impacted to some degree by non-point source pollution. Non-point source pollution is caused by various factors associated with activities of land use such as agriculture, highway and parking lot run-off, landfills, construction, septic systems and underground storage tanks (MA DEP, 1991). Highway maintenance and run-off are significant contributors of non-point source pollution, but do not have as widespread an impact on surface and groundwater as other sources.

Road salt storage, handling and application have the potential to increase levels of water pollution and impact residential wells, which may affect people who are at risk to elevated levels of sodium in their diets. This is a historical issue in the Farmington River Watershed along the Route 8 corridor, particularly in the Town of Otis where elevated levels of sodium in drinking water are suspected to have been impacted by road salting (Farmington River Assessment, 1995 p. VI-24). In the Town of Otis, there is a significant amount of data that indicates that many of the wells, which were tested in the vicinity of the MHD depot and adjacent to the Otis Department of Public Works (DPW) depot, had sodium levels which exceeded the maximum contaminant level of 20 mg/l, which was the standard at the time.

Prior to 1993, 20 mg/l was the maximum contaminant level established by the United States Environmental Protection Agency (EPA) and MA DEP. This level was based on the American Heart Association (AHA) recommendation for people on sodium-restricted diets of 500-1000 mg of sodium per day use distilled water if sodium levels in their drinking water exceeds 20 mg/l. This recommendation by the AHA was based on an assumption that people use approximately two liters of water per day for drinking and cooking, and that water does not account for more than 10% of daily sodium consumption. However, the AHA has no opinion on sodium concentrations for general public drinking water (U.S. Department of Transportation, 1998 p.5).

Since 1993, the EPA and MA DEP do not regulate sodium as a contaminant because of the minor contribution of drinking water to daily sodium consumption. However, as a general guidance level the EPA recommends that the sodium levels in drinking water not exceed 20 mg/l for the at-risk population, (i.e. people on low-sodium diets. The EPA requires that all public wells be monitored for sodium and that concentrations in excess of 20 mg/l be reported to local health officials. As a comparison, European countries such as Germany, Belgium, and the Netherlands allow sodium

concentrations in drinking water up to 125 mg/l (U.S. Department of Transportation, 1998 p.5).

There are also other sources of sodium in groundwater as well, such as salts from septic system leachate, residential water softening devices and other chemicals containing sodium such as sodium hydroxide, which is commonly used in municipal water supplies to adjust Ph levels and to treat lead (MA DEP, 1991). For example, a study conducted by the city of Stamford Health Department in Connecticut of well water in the Stamford area showed a significant difference in total chloride concentrations in wells not treated with a softener. In the water softening process, calcium and magnesium ions are exchanged for sodium or potassium ions. Sodium is more commonly used in water softening.

Most softeners use an on-site regeneration system, which discharges the salt solution into either a septic system or dry well. In the Stamford study, approximately 40% of the sampled wells with high sodium chloride levels seem to have been affected by the discharge of brine used in the water softening process (Kuntz, p.4). According to staff at the MA DEP, a New Hampshire study released in 1997 reports that for every 10 mg/l of hardness removed from water, 4.6 mg/l of sodium is added and 7.6 mg/l of potassium is added (Larson, 1997).

The sodium from road salting can enter ground water supplies by percolating through the soils into ground water. Road run-off can drain directly into reservoirs. If the road salt enters fast flowing rivers and lakes, run-off will usually have little impact, because the sodium concentrations will become quickly diluted (U.S. Department of Transportation p.6). Road salt will usually have a greater impact on groundwater supplies, such as wells, springs, which are primarily recharged by groundwater.

Road salt reaches groundwater in multiple ways depending on factors such as the frequency of precipitation and the drainage characteristics of the roadside soils (Pollock, 1990 p.5). Many of the highways in rural areas of Massachusetts use an “open” drainage system, which do not direct highway run-off into retention basins, but instead direct drainage into roadside ditches and swales (Pollock, 1990 p.2). Also, during winter snowstorms the applied road salt often mixes with snow that has been plowed into a snow bank. When the snow bank melts, the dissolved salt can filter through the soil towards the water table. In cold regions where snow banks accumulate during winter storms, spring thaws can generate higher than normal levels of sodium concentrations (Pollock, 1990 p.2).

The factors that determine whether the salt will actually enter nearby wells and other water supplies include the depth of the wells and their distance from the road, the permeability of the soils and the direction and rate of groundwater flow. Ground water flow in Massachusetts generally moves slowly, ranging from a few feet per year to a couple of hundred feet per year. Therefore, sodium contamination, which may have originated as highway run-off will vary greatly in the time it may take to be detected in nearby wells (Pollock, 1990 p.12).

Although the effects of road salting as a source of non-point source pollution are most commonly associated with groundwater, there are other environmental, structural and economic impacts associated with road salt. Road salt has the potential to cause harm to aquatic life and vegetation such as roadside trees, shrubs and grasses, as well as damage infrastructure by expediting the corrosion process to bridges and automobiles (Keating, 2001 p.9).

Elevated levels of sodium chloride in soils generate an osmotic imbalance in plants, which can inhibit a plant's water absorption and stunt root growth. The salt can also interfere with the uptake of plant nutrients and inhibit the plant's long-term growth. Sodium chloride can cause severe injury to flowering, seed germination, roots and stems, as well as damage vegetation up to 200 meters from roads that are treated with deicing salts. In a report on sodium chloride concentrations in soils in Ontario Canada, sodium exposure as low as 100 mg/kg was alleged to inhibit seed germination and root growth rates for grasses and wildflowers (Keating, 2001 p.9).

Damage to roadside vegetation can also intensify the impacts on drinking water quality by limiting the retention and processing of pollutants transported in run-off, and by diminishing the buffer zones to groundwater sources and reservoirs (Keating, 2001 p.10). Damage to vegetation can also have an impact on wildlife habitat by destroying food resources, shelter and breeding and nesting sites. Another impact common to wildlife is the ingestion of high levels of sodium. For example, many animals drink the salty snow-melt to relieve thirst, which may be toxic to salt-sensitive species. Birds also often mistake the road salt crystals for seeds. The impact of road salt on aquatic life varies. Salt tolerance of fish range from 400-30,000 mg/l, depending on if they are fresh or salt-water species. Rainbow trout, for example, are killed at salt concentrations of 1,000 mg/l. Stream studies in upstate New York suggest that diversity of aquatic species decreases when salinity increases, and that salt tolerant species become dominant during periods of road salting activity (Keating, 2001 p.13).

Road salt can also significantly impact infrastructure. The chloride ions in salt increase the conductivity of water, which induces and expedites corrosion. Road salt corrosion can affect automobile parts, bridge decks, concrete and reinforcing rods. In addition, the affects of road salting can have an economic impact on real estate values of property. For instance, if a potential home buyer inquires about the sodium concentration of a well associated with a prospective home and learns that the well has been affected from sodium infiltration, then the sale may not go through or the selling price may be adjusted downward (Burger, 1997).

Regulation of Sodium Levels:

As previously stated, since 1993 the EPA, the MA DEP and the Massachusetts Department of Public Health (MA DPH) do not recognize or regulate sodium chloride as a contaminant because of the minor contribution of drinking water to daily sodium consumption. However, in accordance with the AHA recommendation, the EPA and the MA DEP have observed 20 mg/l as an advisory limit for drinking water and the EPA has set a "secondary maximum contaminant level for chloride at 250 mg/l. The MA DEP monitors public water supplies for sodium levels.

In the Farmington River Watershed study area along the Route 8 corridor, there are a total of 150 public and private wells. Thirteen of the wells are public wells monitored by the MA DEP. Three wells are in the Town of Becket, seven public wells are located along Route 8 in the Town of Otis, three public wells are in Sandisfield and there are no public wells in Tolland within the study area.

The MA DEP defines a public water system as one that services 25 or more people per day on an average of 60 or more days per year, or has 15 service connections (Gibbs, 2002). There are two classifications of public water systems defined in the Drinking Water Regulations. The first is called Community systems, which is a water source that the same people are regularly exposed to an average of eight hours or greater per day. Examples of these systems would be nursing homes and town halls. Another classification of public water system is a Non-Community system, which has two sub-types: Transient and Non-Transient. A Transient/Non-Community public water system services different people. Examples of these systems include restaurants and campgrounds. A Non-Transient/Non-Community system services the same people up to eight hours or less per day. Examples of these systems include factories, schools, and other workplaces.

The primary difference between these types of water systems is the regularity of exposure of people to the water, which in turn dictates the procedure for testing. MA DEP requires that Community System water sources be tested most extensively. These water supplies require testing for all inorganic compounds. The Non-Transit/Non-Community water supplies are also tested for inorganic compounds, but to a lesser degree. The Transient/Non-Community water supplies are tested for just one inorganic chemical at a time, much less extensive sampling is required for these systems (Gibbs, 2002).

The MA DEP requires water sampling for public wells once every three years. This testing is conducted at the system owners' expense by outside laboratories, which meet MA DEP standards. The data is then analyzed and if the sodium concentrations exceed 20 mg/l the town and the water users are notified. However, no other action is required beyond notification. In Becket, there are no public wells in the study area that exceed 20 mg/l of sodium concentration. There is one public well in Otis, which exceeds 40 mg/l of sodium and two public wells in Sandisfield, which exceed 40 mg/l. In Tolland there are no public wells within the study area.

Massachusetts Highway Department – Salting Policies and Practices

The Massachusetts Highway Department (MHD) conducts snow and ice control activities throughout the Massachusetts highway network. MHD's goal is to promote highway safety and mobility during inclement winter weather. Table I lists the best management practices followed by the MHD for road and depot salt operations.

The MHD most commonly relies on sodium chloride (road salt) and plowing to remove snow and ice from state roads. MHD also uses abrasives such as sand to provide traction on untreated roads (MHD, GEIR, 1995 p.2-1). Sand application, however, is not an efficient deicing option. Although it increases the frictional resistance on icy surfaces, it does not melt snow or ice nor will it prevent binding of ice and snow to pavement (MHD, GEIR, 1995 p.2-2). According to the MHD's Statewide 1996 Snow and Ice Control Policy (Appendix I), sand is expensive to clean up, causes damages to vehicles, and can block drainage systems which causes flooding.

MHD often pre-mixes sand with sodium chloride at a ratio of 1:40 (50 lbs of salt per one ton of sand). This mixture helps to prevent the sand from freezing during storage. The application rate is 240 lbs per lane-mile for both pre-mixtures and pure salt. The pre-mixtures of sand and salt are primarily used in low salt areas designated throughout the state. Currently, there are no low-salt areas designated within the Farmington Watershed study area along Route 8. The reduced salt areas are re-established annually by a vote of the MHD commissioners (MHD, 1996 p.40).

The storage of salt at the MHD and local highway maintenance facilities represents a potential threat to groundwater if the salt is not completely covered and located on an impermeable surface. MHD stores salt spreading equipment, sand, and covered salt at their Otis facility along Route 8 approximately 1,200 feet south of the town's highway maintenance facility, which also stores sand and salt (See Figure 2).

Figure 2. Town of Otis Highway Facility across from the MHD Highway Facility

Figure 3. The MHD Highway Facility along Route 8 in Otis

The Town of Otis stores its road salt in a covered shed at their facility on Route 8 just north of the town's village. The Otis highway department applies a 1:25 salt sand ratio (80 lbs. of salt per one ton of sand) to all of the town's local roads. No salt is stored in that section of Becket located in the Farmington River Watershed or the Route 8 corridor study area. In Sandisfield, salt storage is located within the Farmington River Watershed, but outside of the Route 8 corridor study area. The salt at their facility is covered, however the sand that is pre-mixed with salt is uncovered. Sandisfield is currently awaiting grant funds to construct a new storage shed for the sand and salt (Farmington River Watershed Assessment, 1996 p. IV-24). The Sandisfield Highway Department uses a 1:18 salt-sand mix (110 lbs. salt per ton of sand) on their local roads. The salt storage in Tolland is also located within the Farmington River Watershed, but is located outside of the Route 8 corridor study area. The Tolland highway maintenance facility is located near the town's transfer center on Colebrook River Road. The Tolland Highway Department uses a 1:10 salt/sand mixture (200 lbs. salt per ton of sand) on their local roads (Farmington River Watershed Assessment Report, p. IV-24).

Sodium Remediation:

In the early 1990's, some businesses and residents in the Town of Otis were suspicious of a potential problem with elevated sodium concentrations in the public and private wells along Route 8. Initially, approximately twenty wells were tested by the town; the results of which indicated that sodium levels were elevated in groundwater. At that time, many of the wells had sodium concentrations in excess of 20 mg/l for over a period of years. The town then contacted and worked with the MADEP and the MHD for several years to resolve the issue of sodium-contaminated wells along Route 8 in Otis.

Several elected officials from the Town of Otis felt that MHD was responsible for the well contamination (Farmington River Assessment, 1995 p. VI-24). However, there are many factors cited by the MHD that suggest that they were not entirely responsible for this problem. MHD has procedures and policies established for addressing salt

contamination issues. In the 1996 MHD Salt Contamination Complaint Policy (Appendix II), the MHD clearly states its criteria for investigating sodium-contaminated wells. **MHD will investigate wells if:**

1. **Chloride concentrations are greater than or equal to 250 mg/l.** MHD chose this concentration level because that at 250 mg/l water begins to taste salty to most people. Furthermore, this concentration is defined by the EPA as a "secondary maximum contaminant level" for chloride
2. (a) **A resident of the property is on a specific, documented sodium restricted diet** determined by a physician **to be 1,000 mg/day and to have a sodium concentration in their water supply that exceeds 20 mg/l;**
   (b) **A resident of the property is on specific, documented sodium restricted diet** determined by a physician **to be less than 2,000 mg/day and to have a sodium concentration in their water supply that exceeds 40 mg/l.**

The MHD policy regarding non-community public water supplies is that investigation and remediation of all public water supplies should be conducted in cooperation with the MA DEP. MHD will deny any public water salt complaint that is from a water supplier that is not in full compliance with the MA DEP's "Drinking Water Regulations" 310 CMR 22 for at least one year, including the time MHD investigates the well. The purpose of this policy is to insure that public water suppliers are not just simply registered with the MA DEP, but also comply with the MA DEP's drinking water regulations.

The MHD will deny complaints of sodium-contaminated wells if:

1. **The water is not potable due to the presence of non-highway related contaminants** that exceed the levels of the Massachusetts drinking water standards, **regardless of the salt content of the water;**
2. **The well is poorly constructed**, so that surface contamination can easily enter the well;
3. **There are significant non-MHD sources of salt within the well**, such as sources from municipal salt storage, municipal salt application to local roads, salt applied to private property, water treated chemicals, or other sources of salt contamination.

Based on the MHD Salt Complaint Policy (Appendix II), the MHD will only investigate complaints about salt contaminated wells after the complaint has been submitted in writing attached with water quality data and other evidence of contamination. The MHD will then conduct a site visit; the findings of the site visit will be presented to the MHD salt committee with a recommendation to either conduct a detailed investigation or deny the complaint. If the MHD feels that an in-depth investigation is warranted, water samples are then collected monthly for a one-year period from the water sources of concern. After the MHD conducts an investigation for one-year, a recommendation is made to either gather more data, deny the complaint or conduct remedial actions (MHD, 1996 p.1).

Some of the remedial actions that the MHD may employ if they are found to be the source of sodium contamination include,

- Well replacement
- Connection to a public water supply, if applicable
- Installing a water treatment unit such as a reverse osmosis unit
- Modify or construct a new highway drainage system
- Reduce salt applications on nearby highways
- Eliminate salt use on highways and use alternative deicing materials
- Install and operate a scavenger well

There are a variety of techniques that the MHD has the capacity to implement to reduce the potential impacts of road salting to public and private water supplies. Table I lists the best management practices for road deicing and storage at maintenance depots developed by the MA DEP. These practices identify the best procedures for salt storage and handling, snow dumping, road salt application and employee training.

Table I.

Best Management Practices

Road and Maintenance Depots/Road Deicing

Source: MA Department of Environmental Protection, 1986

Salt Storage and Handling

Cover Salt Piles
Provide for drainage
Keep handling area clean of spilled chemicals
Reduce unnecessary handling through proper shipment planning
Shield truck-loading & unloading from weather

Snow Dumping

Do not dispose snow in primary recharge areas of public wells
Do not dispose of snow at a sanitary landfill
Avoid direct dumping of snow into rivers or water sources
Choose a site to dump snow near a large river with suitable soils for filtering

Road Salt Application

Identify sensitive areas around public water supplies
Ground-speed controllers should be used for all spreaders
Spreaders should be calibrated before winter storms
Determine level of service and application rates for weather types and road types prior to the winter
Salt mixtures with sand, calcium chloride should be used in identified areas
Maintain plow and spreading equipment
After storms determine the amount of materials used, area covered & results
Explore alternatives and conduct experiments as new chemical alternatives are introduced

One of the training programs offered to MHD employees is the Baystate Roads Program located at the University of Massachusetts in Amherst. The program is affiliated with the University's Engineering Department and is focused on training highway personal with the most effective and cost efficient ways to treat roads in inclement winter weather. Some of the issues covered by the Baystate Roads program include comparing proactive pre-storm chemical application to reactive post-storm deicing, factors affecting snow and ice treatment, snow types and preferred treatments, the costs of alternative road treatments and the disadvantages and advantages of sand and alternative deicing chemicals.

Deicing Alternatives:

There are a number of alternative solutions to highway deicing, such as the application of Liquid Calcium Chloride (LCC), Calcium Magnesium Acete (CMA), Magnesium Chloride (MAG) and pre-wetting salt. The result of an Ottawa, Canada study on pre-wetting salt with LCC showed that more material stays on the road surface and less material is lost in run-off (Pollock, 1990 p.18). Pre-wetting the salt with LCC induces the melting action on snow and ice and is effective at a much lower temperature than normal road salt.

The MHD has experimented with two alternative highway-deicing chemicals, Calcium Magnesium Acete (CMA) and Liquid Calcium Chloride (LCC). The first used was CMA in the winter of 1986-1987. It was used to gauge the success of alleviating sodium chloride contamination along Route 138 in Somerset, MA. At that time, CMA was 23 times the cost of salt, thereby not being the most cost-effective approach, however the experiment was successful and CMA was determined by the Massachusetts Highway Department to be an acceptable highway deicing chemical (Pollock, 1990 p.18).

The second alternative deicing chemical, LCC was evaluated by the Massachusetts Highway Department in the winters of 1993, 1994 and 1995 in surrounding Boston area. The experiment was conducted to test whether LCC was equally effective as a "50/50" equal sand and salt mixture. The experiment was documented as a success by the MHD. The cost to purchase and apply LCC to the study area was approximately 15% higher than the cost of salt and sand (MHD, Anti-ice Experiment, 1995 p.12).

The way LCC works is by absorbing moisture from the air and dissolving it to form a liquid solution, when placed on pavement it continues to absorb moisture until equilibrium is reached. LCC also has a very low freezing point of –59° Fahrenheit and has the fastest melting action of any deicing chemical produced (MHD, Anti-ice Experiment, 1995 p.6).

Salt typically loses 75% or greater of its effectiveness to melt snow and ice when temperatures drop 10° from 30° to 20°. At temperatures below 20°, moisture is not available for the salt to use to become a brine solution, which stops ice and snow from forming (MHD, Anti-ice Experiment, 1995 p.6). In order to get salt crystals into brine

solution there must be both moisture and heat. LCC has both elements and works more effectively by lowering the freezing point of water and increasing the number of freeze and thaw cycles (MHD, Anti-ice Experiment, 1995 p.12).

Based on pre-wetting trials with LCC performed by the Minnesota Department of Transportation, reduction in salt use ranged from 10-40%. The salt reduction was achieved by pre-wetting the salt with 32% LCC at a rate of 4-8% by weight. The cost for the Minnesota experiment was approximately $58 per ton for the salt and $0.11 per liter for the LCC, at a Minnesota average application rate of 800 lbs per two-lane mile, the cost savings of pre-wetting totaled $1.42 per two-lane mile (Miner, Better Roads, December 1995 p.4).

According to a 1997 letter to the Town of Otis, the MHD was in the process of requesting funding at that time to equip their trucks with saddle tanks to apply the LCC, and although MHD had not designated the Route 8 corridor within the Farmington Watershed as a "low-salt area", they agreed to make an effort to reduce the amount of road salt used within Otis.

Existing Water Quality Data

Four sets of data from the Town of Otis, the MHD, the Town of Becket and the MA DEP were examined to determine the extent of sodium contamination in public and private water supplies along the Route 8 corridor in the Farmington River Watershed.

All of the available data gathered and analyzed for private wells within the study area were determined to be in accordance with the data gathering and testing procedural standards associated with Quality Assurance/ Quality Control (QA/QC).

The data gathered on behalf of the Town of Otis was collected by a licensed environmental testing laboratory, which must follow the QA/QC guidelines as part of their certification. Additionally, the data gathered by the MHD and the MA DEP were also collected and analyzed by professional scientist trained to follow and regulate the standards of QA/QC water quality sampling (Gibbs, 2002). The well data gathered by the Town of Becket was also and was collected and sampled by MA DEP in 1987 (Motts and Spencer, 1987).

Private Well Data:

The Town of Otis Board of Health provided most of the private well water data. Other private well data for the other communities within the study area are relatively limited, for example there are no private well data available for the Towns of Sandisfield and Tolland and the private well data that are available for the Town of Becket do not come from within the Farmington River Watershed study area.

In the late 1980's, the local businesses and residents of the town of Otis suspected that there was a potential problem with the quality of drinking water in some of the public and private wells along Route 8. The town's planning board hired a private

environmental laboratory, Berkshire Enviro-Labs, Inc., to conduct drinking water analysis for approximately 20 wells within the Farmington River Watershed study area.

All of the wells that were tested were private residential wells except a real estate office and a church, which were commercial uses but did not qualify as public water systems under the MA DEP criteria. Of these wells, 12 had sodium concentrations in excess of 20 mg/l, which was still regulated by the EPA and MA DEP as a water contaminant at that time. Table II shows the sodium levels of the wells tested on behalf of the Town of Otis between the years of 1984 and 1996. The sodium levels of those wells initially tested during the 1980's, that exceeded the maximum contaminant level ranged from 21 mg/l to 720 mg/l.

These high levels of sodium in the drinking water supplies along Route 8 in Otis were in close proximity to the MHD depot, which indicated to local public officials of the town that the road salting and storage practices of the MHD may be the source of sodium pollution to these wells.

Table II. **Town of Otis - Sodium Concentrations - Sampled Wells on Route 8**
Tested By: Water Test Corporation of America, for the Town of Otis

Location	Date	Sodium (mg/l)	Location	Date	Sodium (mg/l)
Adams (resident)	5/14/89	**21**	Higgins (resident)	5/14/89	**78**
Beaudry (resident)	5/14/89	2.1		10/3/91	**94**
Clark (resident)	8/18/88	**56**	Hood (resident)	5/14/89	9.4
	10/3/91	**42**	J&D Marina & Campground	9/11/96	**126**
	10/14/92	**37**	Jasman (resident)	5/14/89	**22**
Coffey (resident)	5/14/89	14		10/3/91	9
Comarato/McNally (resident)	5/14/89	19	Kearin (resident)	5/14/89	12
Crandall	3/22/89	**112**	Lane (resident)	5/14/89	9
	5/14/89	**52**		10/24/96	18
	10/3/91	**66.6**	Maintenance Depot	10/24/96	4.3
Fennelly (resident)	5/14/89	**41**	Mott (resident)	5/14/89	2.1
	10/3/91	**39**	Murphy (resident)	5/14/89	6.4
	1/5/93	**205**	Schilling (resident)	5/13/89	**82**
	10/23/96	**64**		10/3/91	**96**
First Congregational Church	5/14/89	**89**	Slakteris (resident)	5/14/89	**27**
Gage (resident)	5/14/89	**35**		10/24/96	**62**
	10/3/91	**60**	Snow (resident)	5/14/89	**33**
Gaiton (resident)	5/14/89	**33**		10/3/91	**121**
	11/4/96	**52**	Terranova (resident)	10/3/91	**56.2**
Gile	10/31/84	**720**		10/29/96	**70**
	11/2/86	**99**	Town Hall	10/3/91	**148.5**
	8/18/88	**56**		10/24/96	**104**

*** Note:** There are approximately 70 wells along Route 8 in Otis
25 wells were sampled, 23 private and 2 public. Concentrations in bold exceed 20 mg/l

In 1991, the Town of Otis initiated correspondence with the MHD and MA DEP asking for assistance in determining which wells should be replaced and who should be responsible for their replacement. In Otis the MHD decided to conduct an in depth investigation, based on the information provided by the town. The MHD investigation was limited to wells where residents were on sodium-restricted diets of less than 2,000 mg/l per day and had a sodium concentration of 40 mg/l or if the well had a sodium content of 250 mg/l.

Most of the sodium contaminated well complaints were denied by MHD because it was determined by the MHD that other factors degraded the water quality of the well. These factors included bacterial contamination, public water supplies that should have been registered with the MA DEP, and the source of sodium pollution was believed to be the municipal salt storage facility.

Table III shows the sodium levels of wells sampled by the MHD. Of the water quality data collected by the MHD, their tests at their maintenance facility showed the most fluctuation in sodium concentrations. Originally, the MHD maintenance facility well had sodium concentrations of 160 mg/l in 1988 before they had their well replaced in 1992. The sodium levels ranged from 68 mg/l in 1992 to 6 mg/l in 1994, but then increased in concentrations in 1995 up to 20 mg/l.

Table III.

Town of Otis - Sodium Concentrations - Selected Private and Public Wells

Tested By: Massachusetts Highway Department

	Date	Sodium (mg/l)		Date	Sodium (mg/l)
Maintenance Depot	11/22/88	**160**	Snow	9/9/92	**60** w/o softner
	12/16/92	**68**		9/9/92	**136** w/ softener
	12/18/92	10		11/17/92	**42**
	12/19/92	8		12/17/92	**49**
	1/5/93	15		12/21/92	**47**
	1/12/93	15		1/21/93	**51**
	1/29/93	15		2/23/93	**51**
	9/10/93	8		3/25/93	**53**
	3/11/94	4		4/20/93	**38**
	4/14/94	14		5/12/93	**47**
	5/3/94	14		6/15/93	**58**
	7/27/94	8	Crandall	11/17/92	**81**
	8/29/94	6		10/25/94	4.9
	9/30/94	8		11/29/94	4.8
	10/25/94	8		12/20/94	4.6
	11/29/94	16		4/24/95	5.2
	12/20/94	10		6/26/95	3.6
	2/3/95	12		7/27/95	5.4
	3/15/95	12		8/17/95	5.4
	4/24/95	18		9/21/95	4

	6/26/95	**20**
	7/27/95	11
	8/17/95	12
	9/21/95	11
	11/24/95	12
	3/13/96	**24**
Terranova	4/15/92	**54**
	11/17/92	**60**
	12/21/92	**58**
	1/21/93	**56**
	2/23/93	**54**
	3/25/93	**54**
	4/20/93	**54**
	5/12/93	**58**
	6/15/93	**58**
	12/17/93	**60**

	11/24/95	3.7
	12/28/95	3.7
Clark	4/15/92	**36**
	11/17/92	**45**
	12/21/92	**46**
	1/21/93	**40**
	2/23/93	**42**
	3/25/93	**42**
	4/21/93	**44**
	5/12/93	**50**
	6/15/93	**48**
	12/20/93	**44**
Higgins	5/14/89	**78**
Gile	4/15/92	3.8

In all of the wells sampled by the MHD except one, sodium concentrations exceeded the EPA and MADEP advisory limit of 20 mg/l, ranging in concentration levels from 20 mg/l to 136 mg/l. One well tested in 1992 by the MHD was tested with a water softener and without the softener to determine the sodium contribution of the softener. The sodium concentration without the softener was 60 mg/l and the concentration with the softener was 136 mg/l.

Two of the seven sampled wells were replaced by the MHD by 1994. In addition to the MHD replacing their own contaminated well, a residential well with a sodium concentration of 81 mg/l was replaced because the resident was on a restricted sodium diet and complied with the MHD policy regarding well replacement.

The one private well sampled by the MHD that did not have sodium concentrations in excess of 20 mg/l had been replaced by the resident themselves due to unpalatable concentrations of sodium chloride in their well prior to the MHD investigation. Although the owners of this well were hoping to have the MHD reimburse them for the cost of their well replacement, the MHD would only evaluate such a request if samples from both the old well and the new well were conducted for one year. Since sampling of the old well had not been conducted for one year, the residents where unable to receive reimbursement for the cost of their well replacement (MHD, Stevens, 1996).

Although all of the private well data gathered for the Town of Becket is outside of the Farmington Watershed study area, the information is still useful as a comparison of the data within the study area to determine the extent of sodium contamination. The data collected for the Town of Becket was from a 1987 report by Dr. Ward Motts and Mr. Robert Spencer of the Berkshire Regional Planning Commission on the causes and remedies of elevated sodium in groundwater (Appendix III).

Table IV. shows the Becket data samples along Route 8 North, outside the Farmington River Watershed study area. Of the eleven samples, nine wells had sodium levels ranging from 20 mg/l to 110 mg/l. These samples indicate that during this testing period sodium was affecting the quality of water along Route 8 outside of the Farmington watershed study area.

However, along the south section of Route within the Becket portion of the study area, there are approximately 24 private wells, however none of the data for these wells exist, and therefore the water quality of the private water supplies for this area cannot be determined at this time.

Table IV. **Town of Becket - Sodium Concentrations**

Tested By: Dr. Ward Motts & Robert Spencer, 1987

	Date	**Sodium (mg/l)**
Andrews	5/84 - 3/85	2.8 - 4.4
Becket General Store	5/84 - 3/85	**20.0 - 42.0**
Dean	5/84 - 3/85	**33.0 - 40.0**
Fire Dept.	5/84 - 3/85	**30.0 - 72.0**
Frisbee	5/84 - 3/85	10.0 **- 40.0**
Hohl	5/84 - 3/85	**34.0 - 110**
Leonhardt (deep well)	5/84 - 3/85	2.0 - **46.0**
Leonhardt (shallow well)	5/84 - 3/85	1.5 - 5.0
Robinson	5/84 - 3/85	**20.0 - 42.0**
Sweet	5/84 - 3/85	**20.0 - 50.0**
Trembley	5/84 - 3/85	**20.0 - 38.0**

*** Note:** Multiple well tests were done over this time period.
The sodium concentrations are given from lowest to highest

Public Well Data:

According to public well data prepared by the MA DEP, there are thirteen public water supplies along the Route 8 Farmington Watershed study area. Three wells are located in the Town of Becket, seven in the Town of Otis, three in the Town of Sandisfield and no wells in the Town of Tolland. All of the public well data was collected and analyzed by the MA DEP in accordance with QA/QC guidelines (See Table V.).

Table V. **MA DEP Public Well Data - Route 8 Corridor - Farmington Watershed Sodium Concentration Levels**

PWSID	PWS Name	PWS Status*	PWS Class	PWS Town Name	PWS Street Addr	Collection Date	Sodium (mg/L)
1022015	CAMP GREYLOCK FOR BOYS	I	NC	BECKET	RTE 8	15-Jun-95	5.8
1022015	CAMP GREYLOCK FOR BOYS	I	NC	BECKET	RTE 8	15-Jun-95	10
1022015	CAMP GREYLOCK FOR BOYS	I	NC	BECKET	RTE 8	15-Jun-95	7.7
1022015	CAMP GREYLOCK FOR BOYS	I	NC	BECKET	RTE 8	15-Jun-95	9.5
1022009	CAMP LENOX	A	NC	BECKET	2042 NORTH MAIN RD	27-Jun-95	19.5
1022002	BECKET GENERAL STORE	A	NC	BECKET	ROUTE 8	5-May-98	**90**
1022002	BECKET GENERAL STORE	A	NC	BECKET	ROUTE 8	23-Aug-01	**44**
1225014	MOUNTAIN VIEW CAMPGROUNDS	A	NC	OTIS	1856 SOUTH MAIN ST	25-May-95	2
1225014	MOUNTAIN VIEW CAMPGROUNDS	A	NC	OTIS	1856 SOUTH MAIN ST	25-May-95	8.2
1225017	KLONDIKE CAMPGROUND	A	NC	OTIS	ROUTE 8	25-May-95	5
1225017	KLONDIKE CAMPGROUND	A	NC	OTIS	ROUTE 8	25-May-95	3
1225017	KLONDIKE CAMPGROUND	A	NC	OTIS	ROUTE 8	25-May-95	5.3
1225017	KLONDIKE CAMPGROUND	A	NC	OTIS	ROUTE 8	25-May-95	6.2
1225028	TOWN OF OTIS MUNICIPAL BUILDING	A	NC	OTIS	1 NORTH MAIN RD	25-May-95	3.4
1225017	KLONDIKE CAMPGROUND	A	NC	OTIS	ROUTE 8	28-Apr-98	2.9
1225017	KLONDIKE CAMPGROUND	A	NC	OTIS	ROUTE 8	28-Apr-98	4.6
1225028	TOWN OF OTIS MUNICIPAL BUILDING	A	NC	OTIS	1 NORTH MAIN RD	28-Apr-98	2.4
1225036	FARMINGTON RIVER COUNTRY STORE	A	NC	OTIS	119 SOUTH MAIN RD	28-Apr-98	**60**
1225034	OTIS POULTRY FARM	A	NC	OTIS	1570 N MAIN RD	28-Apr-98	4

Table V.
Continued

1225034	OTIS POULTRY FARM	A	NC	OTIS	1570 N MAIN RD	28-Apr-98	2.4
1225014	MOUNTAIN VIEW CAMPGROUNDS	A	NC	OTIS	1856 SOUTH MAIN ST	22-May-98	1.6
1225014	MOUNTAIN VIEW CAMPGROUNDS	A	NC	OTIS	1856 SOUTH MAIN ST	22-May-98	4.8
1225040	FARMINGTON RIVER REGIONAL SCHOOL	A	NTNC	OTIS	555 NORTH MAIN RD	12-Jun-00	4.8
1225036	FARMINGTON RIVER COUNTRY STORE	A	NC	OTIS	119 SOUTH MAIN RD	19-Apr-01	**72**
1225014	MOUNTAIN VIEW CAMPGROUNDS	A	NC	OTIS	1856 SOUTH MAIN ST	9-May-01	3
1225014	MOUNTAIN VIEW CAMPGROUNDS	A	NC	OTIS	1856 SOUTH MAIN ST	9-May-01	5.3
1225017	KLONDIKE CAMPGROUND	A	NC	OTIS	ROUTE 8	27-Aug-01	3.7
1225017	KLONDIKE CAMPGROUND	A	NC	OTIS	ROUTE 8	27-Aug-01	5.3
1225017	KLONDIKE CAMPGROUND	A	NC	OTIS	ROUTE 8	27-Aug-01	3.5
1225017	KLONDIKE CAMPGROUND	A	NC	OTIS	ROUTE 8	27-Aug-01	5
1225034	OTIS POULTRY FARM	A	NC	OTIS	1570 N MAIN RD	27-Aug-01	4.8
1225034	OTIS POULTRY FARM	A	NC	OTIS	1570 N MAIN RD	27-Aug-01	4.8
1225028	TOWN OF OTIS MUNICIPAL BUILDING	A	NC	OTIS	1 NORTH MAIN RD	22-Oct-01	3
1260007	NEW BOSTON INN	A	NC	SANDISFIELD	101 NORTH MAIN STREET	25-May-95	**8.4**
1260009	TUCKERS PLACE	A	NC	SANDISFIELD	61 SOUTH MAIN ST	13-Sep-95	**8.7**
1260009	TUCKERS PLACE	A	NC	SANDISFIELD	61 SOUTH MAIN ST	20-Apr-01	**59**
1260007	NEW BOSTON INN	A	NC	SANDISFIELD	101 NORTH MAIN STREET	27-Aug-01	**42**

*Status
I=Inactive
A=Active

In Becket, the MA DEP has certified Camp Lenox on Route 8 as a public water supply and has required the owner to have the well sampled by an approved water testing lab twice during the last six year time period, first in 1995 and most recently in 2001. In the sample analyzed in 1995, there was a sodium concentration of 19.5 mg/l, just under the 20 mg/l advisory limit. In August of 2001 when the camp's well was tested again, the sodium concentration had dropped to a level of 9.6 mg/l, which is relatively low at less than half the advisory limit.

In the Town of Otis, the public wells in the Route 8 Farmington Watershed study area that were sampled approximately three times over a nine year period from 1993 to 2001 were Otis Poultry Farm, Klondike Campground, Town of Otis's Municipal Building, the Farmington River Country Store, the Farmington River Regional School, the Olde Otis Inn and the Mountain View Campground.

The Otis Poultry Farm was first sampled in 1993, which produced a sodium concentration level of 4.7 mg/l, in 1998 the sodium levels for two on-site wells tested was 4 mg/l. The sodium levels at the Poultry Farm have stayed relatively low for nine years, which indicates that there is not an issue of sodium contamination at the Otis Poultry Farm (MA DEP, 2002).

The Klondike Campground has four wells that have been tested for the MA DEP three times, once in 1995, 1998 and 2001. In 1995 all four wells were tested and respective sodium concentrations were 5.0, 3.0, 5.3, l, and 6.2 mg/l. In 1998 just wells # 1 and # 4 were tested and their respective sodium concentrations were 2.9 mg/l and 4.6 mg/l. Most recently in August of 2001, all four wells were sampled again and their sodium levels were 3.7, 5.3, 3.5 and 5 mg/l. The sodium concentrations found in the water supplies at Klondike Campground have remained consistently low during the years between sampling and therefore indicate that sodium contamination is not affecting the quality of the campground's water (MA DEP, 2002).

The Town of Otis's relatively new municipal building, Town Hall has been tested three times by the MA DEP, once in 1995, 1998 and 2001. In 1995, around the time the new Town Hall was built, the sodium concentration level was 3.4 mg/l, in 1998 the sodium level decreased to 2.4 mg/l. The most recent sample collected in October of 200, had a sodium concentration of 3 mg/l. The sodium levels for the Otis Municipal Building are very low and have remained relatively consistent during a six year time period, therefore sodium contamination does not seem to be affecting the quality of the water at the Otis Town Hall (MA DEP, 2002).

The Farmington River Country Store well was also tested three times, once in 1995, 1998 and 2001. In the 1995 the well sample produced sodium concentration of 8 mg/l. Three years later in 1998, the well sample produced a sodium concentration of 60 mg/l, over seven times the 1995 reading. In 2001 the sodium level had increased again to 72 mg/l. The sodium concentration levels at the Farmington River Country Store indicate that sodium contamination is occurring. The sharp increase of sodium content between 1995 and 1998 suggests that a significant source of sodium entered the well during that

time period. However, in order to determine the exact source of pollution, a more detailed study and analysis will need to be conducted (MA DEP, 2002).

The Farmington River Regional School, just north of the Otis village center, was built in 1998 and the well was tested in June, 2000. At that time the sodium concentration was 4.8 mg/l, which suggests little threat of sodium affecting the quality of water in this well (MA DEP, 2002). The school well was also tested on June 5, 1997 and sodium was 5 mg/l.

The Olde Otis Inn, near the town's village center, is also relatively new and has had its public well tested once in April of 2001. The sodium concentration level was 10.5 mg/l at that time, which indicates that sodium contamination is not significant (MA DEP, 2002).

The Mountain View Campground on Route 8, south of the town's village center, has had its two wells sampled three times, once in 1995, 1998 and 2001. In 1995, the campground's wells had sodium concentrations of 2 mg/l in well # 1 and 8.2 mg/l in well # 2. In 1998, well #1 decreased to 1.6 mg/l and well #2 decreased to 4.8 mg/l, but in 2001 both wells increased slightly in sodium concentrations to 3 mg/l for well #1 and 5.3 mg/l for well #2 (MA DEP, 2002).

In the Town of Sandisfield, the MA DEP regulates three public water supplies within the Farmington Watershed study area, the New Boston Inn and Restaurant, M.J. Tucker's Plac, and the New Boston Nursing Home.

The New Boston Inn and Restaurant, at the intersection of Route 8 and Route 57 has had its well sampled twice, once in 1995 and in 2001. In 1995 the samples sodium content level was 8.4 mg/l and in the most recent sample of August 2001, the level had increased over 5 times to 42 mg/l. This data suggests that there has been sodium contamination affecting the well during the six-year time period between testing. The source of the significant increase in the level of sodium is currently not known. A more detailed study and analysis should be conducted to determine the exact source of sodium pollution (MA DEP, 2002).

M.J. Tucker's Place, located on Route 8 south towards the Town of Tolland, has had its public well tested twice. The first sample was in 1995 and its sodium concentration level was 8.7 mg/l. Six years later in 2001 the well was sampled again and its sodium content level had increased nearly seven times to 59 mg/l. The sodium concentrations for the public water supply at M.J. Tuckers place seem to indicate that a significant source of sodium pollution has affected the quality of the well's water during the six-year time period between MA DEP testing. Again, a more detailed study and analysis is needed to determine the exact source of the sodium pollution (MA DEP, 2002).

Sodium analyses conducted for the New Boston Nursing Home reported concentrations of 12.5 mg/l in August 1995, 15 mg/l in September 1998, and 22 mg/l in August 2001.

The Farmington River:

Data for sodium concentration levels in the Farmington River was not available for this study. However, the Draft 1996 Farmington River Assessment report states that due to "the very rural character of the basin and the absence of any point source discharges, any water quality problems in the basin will be the result of non-point source pollution" (Farmington River Watershed Assessment, 1996 p.4).

At the Farmington River Watershed Team meeting in January of 1996, representatives of the Town of Sandisfield stated that road salting practices, the lack of trash receptacles and failing septic systems were problems that may negatively affect water quality in the Farmington River Basin (Farmington River Watershed Assessment, 1996 p.4).

The Massachusetts Division of Fish and Wildlife (DFW) conducted a fish survey in the summer of 2001 in several brooks surrounding the Farmington River, as well as in the main stem of the Farmington River. The conductivity measurements can be used to estimate the amount of dissolved salts in the water, but do not identify individual ions or potential sources. The conductivity is measured in microsiemens per liter. The conductivity levels for the main stem of the Farmington River were relatively high, ranging from 200-250 microsiemens/liter, compared to the surrounding brooks, which had conductivity levels between 50 and 80 microsiemens/l (Madden, 2002).

An earlier study of the Farmington River by the Massachusetts Division of Watershed Management in 1996 assessed the biologic quality of the Farmington River. A comparison of sections of the West Branch Farmington River in Otis, upstream and downstream of the MHD facility revealed no impacts on "the downstream aquatic community in terms of water quality and habitat quality, save for localized effects of deposition immediately adjacent to the yard, where sampling was not conducted (Massachusetts Division of Watershed Management, 1997, p. 4). This study suggests that road salt may not have an impact on the Farmington River since the sodium would be heavily diluted by stormwater drainage and the flow of the river.

Summary:

Road salt is a source of non-point source pollution that has potentially impacted the private and public water supplies along the Route 8 corridor within the Farmington River Watershed. Although there are a number of non-point source pollutants that may affect the quality of water, the practice of road salting, which has been studied and determined to increase sodium chloride levels in groundwater, may have been a primary source of sodium contamination in the Town of Otis. However, there is a need for more recent testing of private wells to determine if this problem continues.

There are approximately 150 wells along the Route 8 Farmington Watershed study area, approximately 140 of them are private wells and 13 are public wells. Forty-seven wells (32%) were sampled between 1984 and 2001. During this time period a total of 147 samples have been analyzed and 21 wells had sodium concentration levels in excess of 20 mg/l. Of these 21 wells, 19 wells had sodium concentrations greater than 40 mg/l and one well had a sodium level greater than 250 mg/l.

The MHD is one of the most active highway departments in the country in terms of salt monitoring and remediation. The MHD has established guidelines for salt storage and road salting, as well as guidelines to address complaints of salt-contaminated wells. These guidelines call for the MHD to use the best practices and technology available to them in dealing with salt storage, as well as to employ the most cost effective and efficient deicing procedures.

The review of public and private water supply data available for the Route 8 corridor within the Farmington Watershed study area indicates a lack of information that need to be determined before an accurate assessment of the groundwater quality can be determined.

Data Gaps:

- No data exist for private wells in the Town of Sandisfield or the Town of Tolland, which only has one private well;
- No water quality data exists in the Town of Becket for private wells along Route 8 in the Farmington Watershed
- Available private well data for the towns of Otis and Becket are outdated and not contiguous
- Public water systems that are legally registered with the MA DEP are routinely tested and have available data every three years for sodium.
- Data for sodium concentrations in the Farmington River are not available. However, the rate of dilution in the river may make salt concentrations in the river inconsequential

In the past residents and officials of the Town of Otis have had concerns regarding salt pollution within groundwater wells along Route 8. Based on the more

recent public well data from the MA DEP, the Town of Sandisfield had three public water supplies, the New Boston Inn and Restaurant, New Boston Nursing Home, and M.J. Tucker's Place that experienced increased sodium concentrations by five to six times as much as previously recorded within a six-year time period. While the statistical significance of a sample population of three wells may be questionable, an upward trend in sodium concentrations in groundwater wells is borne out in each of the three Sandisfield public water systems. Additionally, in the Town of Otis the Farmington River Country Store is also a public water supply, which has had its sodium concentration level increase by seven times within a three-year period, also suggesting that there may be a significant source of contamination polluting the well. These public wells may be important locations for further study.

Based on the available data and the number of private and public well samples that have experienced elevated levels of sodium concentrations, and given the lack of point sources of pollution along the Route 8 corridor, there may be some relationship between road salting and the ground water contamination of wells within the Farmington Watershed study. Water quality testing should be performed at regular intervals to determine the actual sources of elevated sodium levels.

Recommendations:

Based on the existing data presented in this report, there are several options that the Farmington River Watershed Team may pursue to determine the causes of sodium non-point source pollution in the public and private wells along the Route 8 corridor and reduce any future impacts from non-point sources:

- Organize private well testing in Becket, Sandisfield and Tolland, as well as update private well testing data in Otis;

- Seek funds to conduct a larger more scientific study, to look at water supplies outside of the Route 8 corridor in order to determine how much sodium naturally occurs and how much is caused by humans and to identify potential groundwater flows and environmental impacts to the Farmington River;

- Encourage involvement of town highway departments in highway training programs, such as the Bay State Roads Program at the University of Massachusetts at Amherst;

- Encourage the Massachusetts Highway Department to become an active member of the Farmington River Watershed Team and to assist in addressing issues of sodium non-point source pollution along Route 8;

- Gather information about the criteria used by Massachusetts Highway Department to designate a "low-salt area." Use this information and meetings with Massachusetts Highway Department to determine if the Route 8 corridor should be designated as a "low-salt area" and/or a demonstration area for the use of available alternative chemical deicing solutions.

In conclusion, the public and water quality data along the Route 8 corridor suggests that further investigation is needed to determine the causes of non-point source pollution in the Farmington River Watershed. The alternatives listed above are not in exact order and may be pursued concurrently or separately as each opportunity presents itself. The Farmington River Watershed Team along with other stakeholders in the watershed will ultimately decide the best strategy to address the issue of sodium pollution along the Route 8 corridor.

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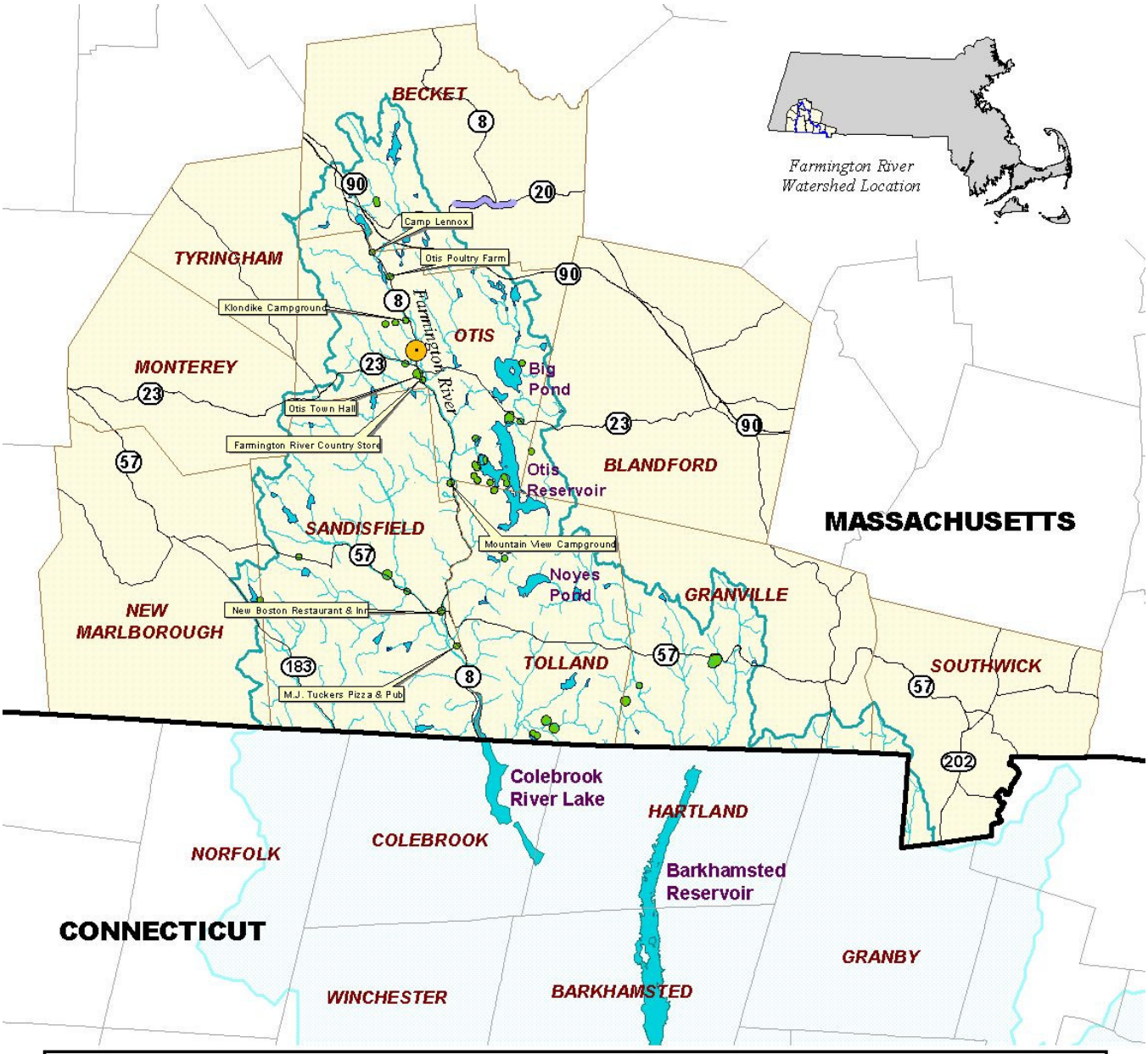
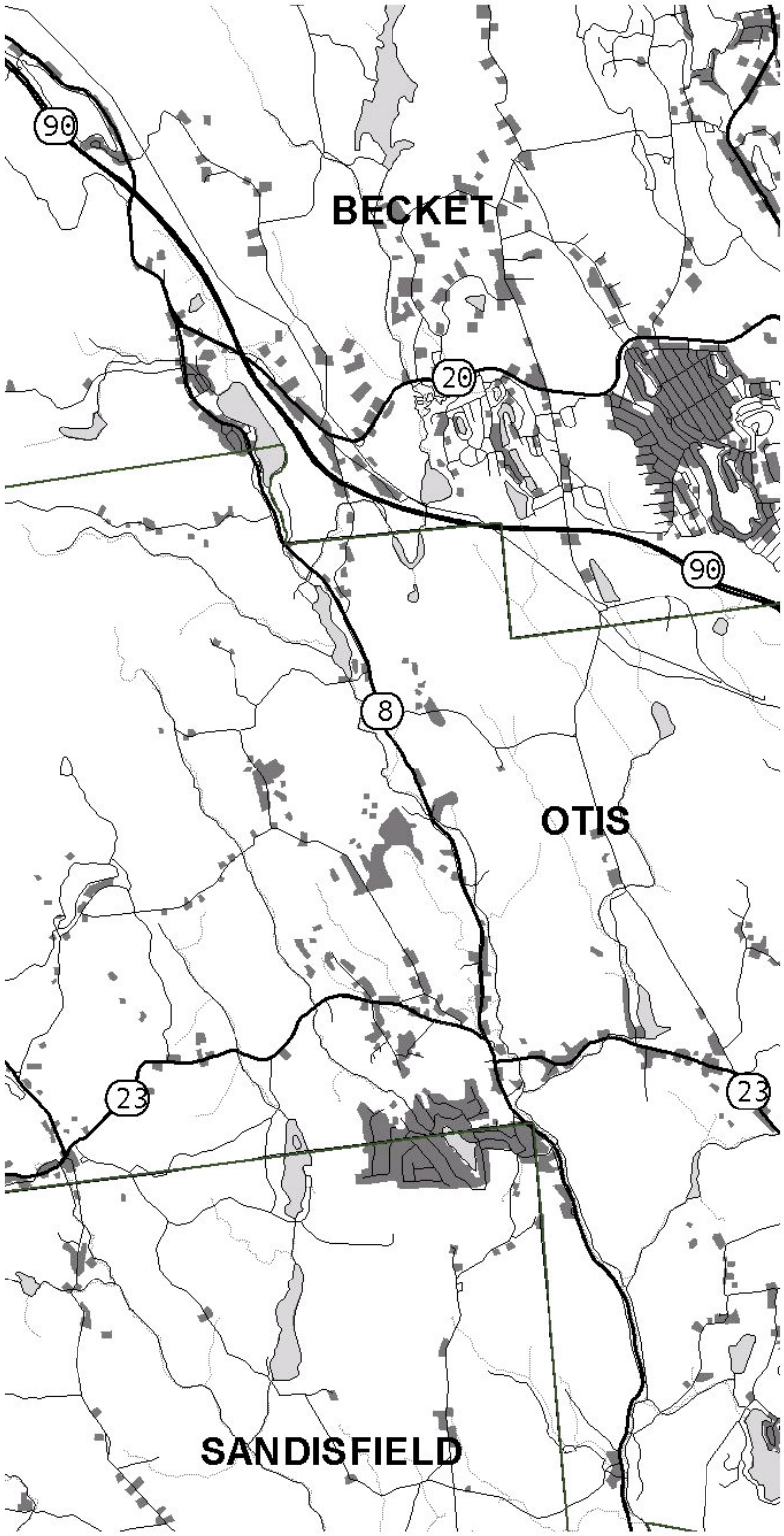
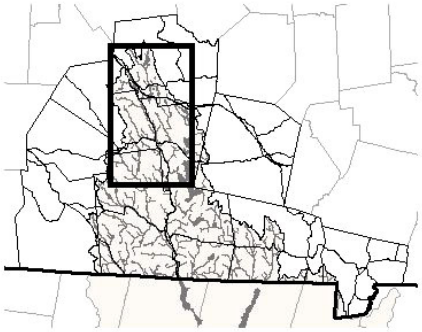

BECKET
TYRINGHAM
MONTEREY
OTIS
SANDISFIELD
NEW MARLBOROUGH
BLANDFORD
GRANVILLE
TOLLAND
SOUTHWICK
MASSACHUSETTS
Farmington River Watershed Location
Camp Lennox
Otis Poultry Farm
Klondike Campground
Farmington River
Big Pond
Otis Town Hall
Farmington River Country Store
Otis Reservoir
Mountain View Campground
Noyes Pond
New Boston Restaurant & Inn
M.J. Tuckers Pizza & Pub
Colebrook River Lake
HARTLAND
COLEBROOK
NORFOLK
Barkhamsted Reservoir
CONNECTICUT
GRANBY
WINCHESTER
BARKHAMSTED
8
90
20
23
57
183
202
Farmington River Watershed
Farmington River Watershed (MA)
Farmington River Watershed (CT)
Lakes & Ponds
Streams & Rivers
Interim Wellhead Protection Areas
Watershed Towns
Roads
State Highway Salt Shed
State Highway Designated Reduced Salting
0 2 4 6 Miles
Source: Massachusetts Geographic Information System (MassGIS), Executive Office of Environmental Affairs



Farmington River Watershed

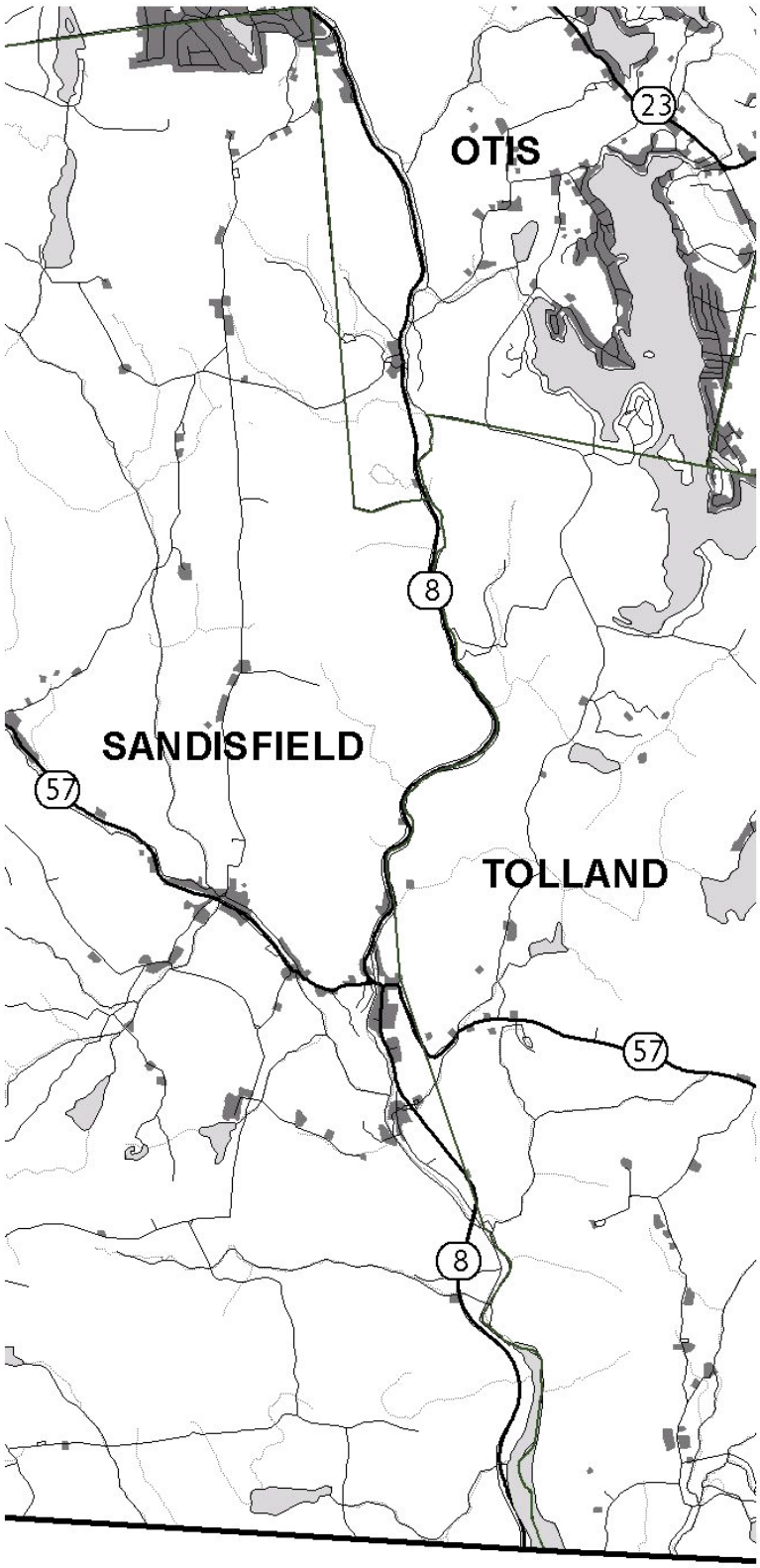
Residential Landuse
Upper Route 8 Corridor



Residential Landuse

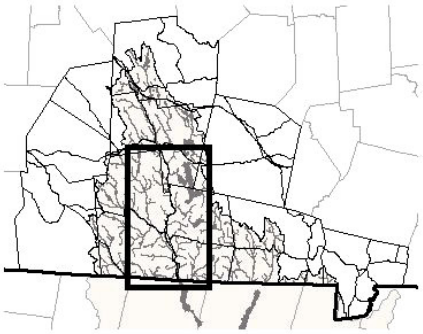
0.4 0 0.4 0.8 1.2 Miles

Source: Massachusetts Geographic Information System (MassGIS), Executive Office of Environmental Affairs



Farmington River Watershed

Residential Landuse
Lower Route 8 Corridor



Residential Landuse

0.4 0 0.4 0.8 1.2 Miles

Source: Massachusetts Geographic Information System (MassGIS), Executive Office of Environmental Affairs